

We Claim:

1. A probe for detecting anions in a sample using capillary electrophoresis
5 characterized in that the probe is comprised of one or more vinylogous carboxylic acid
compounds.

2. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid
compounds is comprised of: one or more enol functional groups in conjugation with one or more
10 carbonyl functional groups through one or more carbon-carbon or carbon nitrogen double bonds.

3. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid
compounds include keto-enol tautomers of said compounds.

4. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid
compounds include aromatic compounds having stabilized resonance structures that are
15 vinylogous carboxylic acids.

5. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid
compounds include hetero-atom analogues of keto-enol tautomers.
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6. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid
compounds include heteroatom aromatic compounds having stabilized resonance structures that
are vinylogous carboxylic acids.
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7. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid
compounds is 3,4-dihydroxy 3-cyclobutene 1,2-dione (squaric acid).

8. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid compounds is 2,5-dihydroxy 1,4 benzoquinone.

9. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid compounds is 4,5-dihydroxy 4-cyclopentene 1,2,3-trione (croconic acid).

10. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid compounds is 2-hydroxy 2,4,6-cycloheptatrienone (tropolone).

11. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid compounds is 5,5 dimethyl 1,3 cyclohexane dione (dimedone).

12. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid compounds is 6 hydroxy 1 tetralone.

13. The probe of Claim 1 wherein said one or more vinylogous carboxylic acid compounds are selected from the group of: 3,4-dihydroxy-3-cyclobutane-1,2-dione (squaric acid); 2,5 dihydroxy 1,4 benzoquinone, and 4,5dihydroxy-4-cyclopentene 1,2,3 trione (croconic acid); 2-hydroxy 2,4,6-cycloheptatrienone (tropolone); 5,6 dihydroxy 5 cyclohexane 1,2,3,4 tetraone (rhodizonic acid); 2-hydroxy 1,4-napthoquinone; 3-oxo l-gulofuranolactone; 2,2-dimethyl 1,3-dioxane 4,6 dione; 4-ketobutyrolactam; 5.5-dimethyl 1,3-cyclo hexane dione; tetrahydrofuran 2,4-dione; 6-hydroxy 1-tetralone; 2,3 dihydroxy 2 cyclopropene 1 one (deltic acid) and uric acid.

14. The probe of Claim 13 wherein said group of vinylogous compounds include substituted forms wherein the vinylogous carboxylic acid UV-chromophore is maintained.

15. The probe of Claim 1 wherein said ions in said sample are anions and are selected

from the group of: bromide, carbonate, bicarbonate, chloride, fluoride, nitrate, nitrite, phosphate and sulfate and small molecular weight organic anions.

16. A probe for detecting cations in a sample using capillary electrophoresis characterized in that the probe is comprised of derivatives of one or more vinylogous carboxylic acid compounds.

17. The probe of Claim 10 wherein said vinylogous carboxylic acid compounds include positively charged cationic ester derivatives of said compound.

18. The probe of Claim 10 wherein said vinylogous carboxylic acid compounds include positively charged cationic amide derivatives of said compound.

19. The probe of Claim 10 wherein said ions in said sample are cations and are selected from the group of: Na^+ , K^+ , Mg^{+2} , Ca^{+2} , and small molecular weight organic cations.

20. A background electrolyte for detecting ions in a sample using capillary electrophoresis by indirect detection, comprising:
at least one probe comprised of one or more vinylogous carboxylic acid compounds; and
a buffer electrolyte.

21. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is comprised of: one or more enol functional groups in conjugation with one or more carbonyl functional groups through one or more carbon-carbon or carbon nitrogen double bonds.

22. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds include keto-enol tautomers of said compounds.

23. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds include aromatic compounds having stabilized resonance structures that are vinylogous carboxylic acids.

5 24. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds include hetero-atom analogues of keto-enol tautomers.

10 25. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds include heteroatom aromatic compounds having stabilized resonance structures that are vinylogous carboxylic acids.

26. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is 2,3-dihydroxy 3-cyclobutene 1,2-dione (squaric acid).

15 27. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is 2,5-dihydroxy 1,4 benzoquinone.

28. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is 4,5-dihydroxy 4-cyclopentene 1,2,3-trione (croconic acid).

20 29. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is 2-hydroxy 2,4,6-cycloheptatrienone (tropolone).

25 30. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is 5,5 dimethyl 1,3 cyclohexane dione (dimedone).

31. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds is 6 hydroxy 1 tetralone.

32. The background electrolyte of Claim 20 wherein said one or more vinylogous carboxylic acid compounds are selected from the group of:

3,4-dihydroxy-3-cyclobutane-1,2-dione (squaric acid); 2,5 dihydroxy 1,4 benzoquinone, and 4,5dihydroxy-4-cyclopentene 1,2,3 trione (croconic acid); 2-hydroxy 2,4,6-cycloheptatrienone (tropolone); 5,6 dihydroxy 5 cyclohexane 1,2,3,4 tetraone (rhodizonic acid); 2-hydroxy 1,4-napthoquinone; 3-oxo 1-gulofuranolactone; 2,2-dimethyl 1,3-dioxane 4,6 dione; 4-ketobutyrolactam; 5.5-dimethyl 1,3-cyclo hexane dione; tetrahydrofuran 2,4-dione; 6-hydroxy 1-tetralone; 2,3 dihydroxy 2 cyclopropene 1 one (deltic acid) and uric acid.

33. The background electrolyte of Claim 20 wherein said group of vinylogous compounds include substituted forms wherein the vinylogous carboxylic acid UV-chromophore is maintained.

34. The background electrolyte of Claim 20 wherein said background electrolyte is provided in a kit for use in a capillary electrophoresis system.

35. The probe of claims 1 or 20 wherein said probe is provided in a kit for use in a capillary electrophoresis system.

36. The background electrolyte of Claim 20 wherein said background electrolyte is provided in a capillary electrophoresis system.

37. The probe of claims 1 or 20 wherein said probe is provided in a capillary electrophoresis system

38. The background electrolyte of Claim 20 wherein the one or more vinylogous carboxylic acid compounds are present at a concentration in the range of about 2 to 5 mM.

39. A method of detecting ions in a sample using a capillary electrophoresis system having a capillary, comprising:

filling the capillary with a background electrolyte containing one or more probes comprised of one or more vinylogous carboxylic acid compounds;

5 introducing the sample into the capillary,

applying an electrical field along the capillary to cause the ion in the sample to move and separate along the capillary to a detection region, and

detecting the ions indirectly by ultraviolet (UV) photometric detection

10 40. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds is comprised of: one or more enol functional groups in conjugation with one or more carbonyl functional groups through one or more carbon-carbon or carbon nitrogen double bonds.

15 41. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds include keto-enol tautomers of said compounds.

20 42. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds include aromatic compounds having stabilized resonance structures that are vinylogous carboxylic acids.

43. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds include hetero-atom analogues of keto-enol tautomers.

25 44. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds include heteroatom aromatic compounds having stabilized resonance structures that are vinylogous carboxylic acids.

45. The method of Claim 39 wherein said one or more vinylogous carboxylic acid

compounds is 2,3-dihydroxy 3-cyclobutene 1,2-dione (squaric acid).

46. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds is 2,5-dihydroxy 1,4 benzoquinone.

47. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds is 4,5-dihydroxy 4-cyclopentene 1,2,3-trione (croconic acid).

48. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds is 2-hydroxy 2,4,6-cycloheptatrienone (tropolone).

49. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds is 5,5 dimethyl 1,3 cyclohexane dione (dimedone).

50. The method of Claim 39 wherein said one or more vinylogous carboxylic acid compounds is 6 hydroxy 1 tetralone.

51. The probe of Claim 39 wherein said one or more vinylogous carboxylic acid compounds are selected from the group of: 3,4-dihydroxy-3-cyclobutane-1,2-dione (squaric acid); 2,5 dihydroxy 1,4 benzoquinone, and 4,5dihydroxy-4-cyclopentene 1,2,3 trione (croconic acid); 2-hydroxy 2,4,6-cycloheptatrienone (tropolone); 5,6 dihydroxy 5 cyclohexane 1,2,3,4 tetraone (rhodizonic acid); 2-hydroxy 1,4-napthoquinone; 3-oxo 1-gulofuranolactone; 2,2-dimethyl 1,3-dioxane 4,6 dione; 4-ketobutyrolactam; 5.5-dimethyl 1,3-cyclo hexane dione; tetrahydrofuran 2,4-dione; 6-hydroxy 1-tetralone; 2,3 dihydroxy 2 cyclopropene 1 one (deltic acid) and uric acid.

52. The method of Claim 39 wherein said vinylogous carboxylic acid compounds include positively charged cationic ester derivatives of said compound.

53. The probe of Claim 39 wherein said vinylogous carboxylic acid compounds include positively charged cationic amide derivatives of said compound.

54. The method of Claim 39 where said capillary has an interior that is treated to reverse cathodal electro osmotic flow.

55. The method of Claim 39 where said one or more probes are selected such that ions of differing molecular weight may be detected in said sample.

56. The method of Claim 39 where said ions are anions.

57. The method of Claim 39 wherein said ions are cations, and said one or more probes are comprised of positively charged cationic ester derivatives of said vinylogous carboxylic acid compounds or positively charged cationic amide derivatives of said vinylogous carboxylic acid compounds.

58. The method of Claim 56 where said capillary is an anodal capillary and anodal flow of said anions occurs within said capillary.

59. The method of Claim 56 where said background electrolyte includes an EOF modifier and anodal flow of said anions occurs within said capillary, and wherein said one or more probes is of sufficiently high molar absorptions that its concentration is low enough to avoid precipitating the modifier within the capillary.

60. A capillary electrophoresis apparatus for detecting ions in a sample, comprising:
a capillary having a background electrolyte containing one or more probes comprised of one or more vinylogous carboxylic acid compounds;
an electrical source which applies an electrical field along the capillary to cause the ions

to move and separate along the capillary to a detection region, and
a detector which detects the ions by indirect ultraviolet (UV) photometric detection.

61. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
5 compounds is comprised of: one or more enol functional groups in conjugation with one or more
carbonyl functional groups through one or more carbon-carbon or carbon nitrogen double bonds.

62. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
10 compounds include keto-enol tautomers of said compounds.

63. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
15 compounds include aromatic compounds having stabilized resonance structures that are
vinylogous carboxylic acids.

64. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
20 compounds include hetero-atom analogues of keto-enol tautomers.

65. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
25 compounds include heteroatom aromatic compounds having stabilized resonance structures that
are vinylogous carboxylic acids.

66. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
30 compounds is 2,3-dihydroxy 3-cyclobutene 1,2-dione (squaric acid).

67. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid
35 compounds is 2,5-dihydroxy 1,4 benzoquinone.

68. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic

acid compounds is 4,5-dihydroxy 4-cyclopentene 1,2,3-trione (croconic acid).

69. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid compounds is 2-hydroxy 2,4,6-cycloheptatrienone (tropolone).

70. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid compounds is 5,5 dimethyl 1,3 cyclohexane dione (dimedone).

71. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid compounds is 6 hydroxy 1 tetralone.

72. The apparatus of Claim 60 wherein said one or more vinylogous carboxylic acid compounds are selected from the group of: 3,4-dihydroxy-3-cyclobutane-1,2-dione (squaric acid); 2,5 dihydroxy 1,4 benzoquinone, and 4,5dihydroxy-4-cyclopentene 1,2,3 trione (croconic acid); 2-hydroxy 2,4,6-cycloheptatrienone (tropolone); 5,6 dihydroxy 5 cyclohexane 1,2,3,4 tetraone (rhodizonic acid); 2-hydroxy 1,4-napthoquinone; 3-oxo 1-gulofuranolactone; 2,2-dimethyl 1,3-dioxane 4,6 dione; 4-ketobutyrolactam; 5.5-dimethyl 1,3-cyclo hexane dione; tetrahydrofuran 2,4-dione; 6-hydroxy 1-tetralone; 2,3 dihydroxy 2 cyclopropene 1 one (deltic acid) and uric acid.

73. The apparatus of Claim 60 wherein said vinylogous carboxylic acid compounds include positively charged cationic ester derivatives of said compound.

74. The apparatus of Claim 60 wherein said vinylogous carboxylic acid compounds include positively charged cationic amide derivatives of said compound.

75. A kit for performing capillary electrophoresis comprising:
one ore more reagents, wherein the one or more reagents include one or more probes

comprised of one or more vinylogous carboxylic acid compounds.

76. The kit of Claim 75 wherein said reagents further comprise:
one or more buffer solutions.

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77. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is comprised of: one or more enol functional groups in conjugation with one or more carbonyl functional groups through one or more carbon-carbon or carbon nitrogen double bonds.

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78. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds include keto-enol tautomers of said compounds.

79. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds include aromatic compounds having stabilized resonance structures that are vinylogous carboxylic acids.

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80. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds include hetero-atom analogues of keto-enol tautomers.

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81. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds include heteroatom aromatic compounds having stabilized resonance structures that are vinylogous carboxylic acids.

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82. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is 2,3-dihydroxy 3-cyclobutene 1,2-dione (squaric acid).

83. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is 2,5-dihydroxy 1,4 benzoquinone.

84. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is 4,5-dihydroxy 4-cyclopentene 1,2,3-trione (croconic acid).

85. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is 2-hydroxy 2,4,6-cycloheptatrienone (tropolone).

86. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is 5,5 dimethyl 1,3 cyclohexane dione (dimedone).

87. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds is 6 hydroxy 1 tetralone.

88. The kit of Claim 75 wherein said one or more vinylogous carboxylic acid compounds are selected from the group of: 3,4-dihydroxy-3-cyclobutane-1,2-dione (squaric acid); 2,5 dihydroxy 1,4 benzoquinone, and 4,5dihydroxy-4-cyclopentene 1,2,3 trione (croconic acid); 2-hydroxy 2,4,6-cycloheptatrienone (tropolone); 5,6 dihydroxy 5 cyclohexane 1,2,3,4 tetraone (rhodizonic acid); 2-hydroxy 1,4-napthoquinone; 3-oxo 1-gulofuranolactone; 2,2-dimethyl 1,3-dioxane 4,6 dione; 4-ketobutyrolactam; 5.5-dimethyl 1,3-cyclo hexane dione; tetrahydrofuran 2,4-dione; 6-hydroxy 1-tetralone; 2,3 dihydroxy 2 cyclopropene 1 one (deltic acid) and uric acid.

89. The kit of Claim 75 wherein said vinylogous carboxylic acid compounds include positively charged cationic ester derivatives of said compound.

90. The kit of Claim 75 wherein said vinylogous carboxylic acid compounds include positively charged cationic amide derivatives of said compound.